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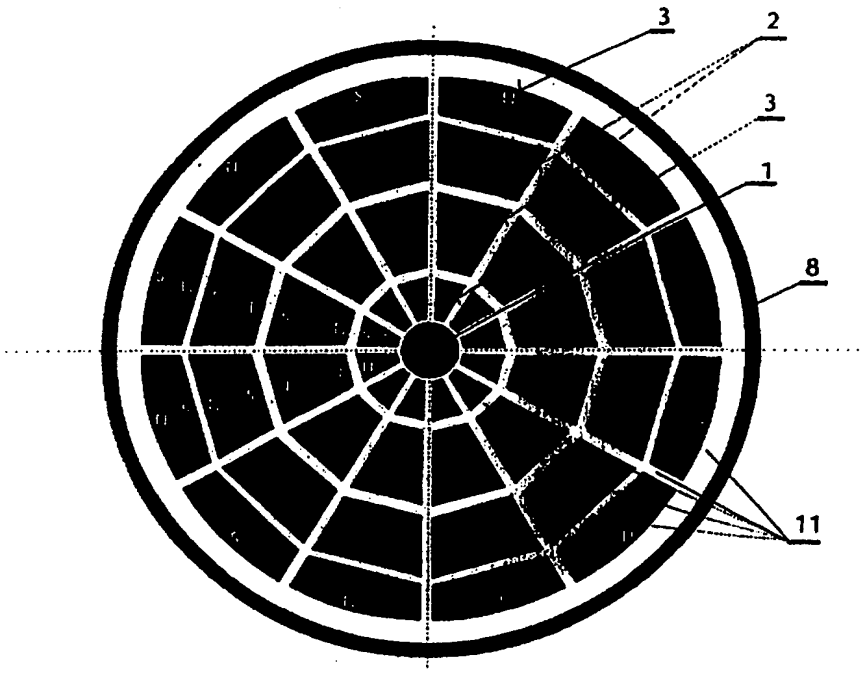
(54) Title: ROTOR FOR AN ELECTRIC GENERATOR

(57) Abstract

A rotor for an electric generator, having an axle (1) provided with an even number of ferrite–magnet segments (3), and surrounded by a grooved laminated stator with coils. The ferrite–magnet segments (3) are arranged in at least two layers on the axle (1), and steel–magnet segments (2) of one or more layers are provided between the ferrite–magnet segments (3), and the segments (2, 3) attached to the axle (1) all together constitute a cylinder, and the segments (2, 3) have identical polarity in radial direction from the axle (1), and the segments (2, 3) in any common layer have alternating polarity in circular direction.



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Rotor for an electric generator

This invention relates to a rotor for an electric generator, having an axle provided with an even number of ferrite-magnet segments, or to a rotor having claw-type pole cups with permanent magnet discs being on the axle of the rotor within the pole cups. The rotor is surrounded by a grooved laminated stator with coils.

Electric generators are commonly used in the electrical industries. Their main function is to transform mechanical energy into electrical energy.

Three-phase generators have been described per se in the Bosch Technical Guideline published in 1995 (OMIKK, Budapest). In this booklet three different type of electric generators are involved on pages 26-29.

The slip-ring electric generators with claw poles have a compact design with a good power and little weight. The field of their use is quite wide. At a given length/diameter ratio considerable electric power generation can be achieved at still a low material consumption level in the production. This type of electric generators has a dumpy bulk with a relatively large diameter and small length. This shape yields advantageous thermal characteristics. The classification "claw poles" emphasises a rotor construction in which the semi- poles of different polarities are mounted on the axle of the rotor with engaged claw shape poles with alternating polarity. The poles surround the exciting coil of a ring (toroidal) shape provided on a core. The slip-ring electric generators with claw poles usually produced with cups, in which case the core of the stator is placed between two shield-like elements, called caps, located on the driven side and the slip-ring side. The two caps include the bearings of the rotor as well. The available number of poles is limited: if this

number is too small this means less efficiency, while if this number is too great this leads to an increased magnetic loss (dispersion). For this reason generators usually are realised with 12, 14 or 16 poles.

Salient pole generators can be used in a wide range of powers. Such generators can be used with large vehicles. The three-phase winding and the coils are similar to that of the claw pole generators. The rotor, however, has a quite different construction, the salient pole rotor is provided with 4 or 6 single elongated poles with its own exciting coils. The rotor also defines the outer shape of the generator. The cylindrical housing comprises the stator with three-phase windings, and cooling blocks. Bearing shields have been arranged at the ends of the housing (on the driven side and on the slip-ring side). The single poles with the excitation coils are mounted on the bearing supported rotor, and supplied with current through slip-rings and coal-brushes. Salient pole generators have larger sizes than the others and the regulator unit is to be placed separately from the heat produced.

It is a disadvantage of these constructions that due to the slip-rings, coal-brushes, cooling blocks and other additional elements, the friction, the abrasion and heat generation are considerable. Thus the costs of maintenance and repair are fairly high.

In those cases where durability and useful life are important criteria, generators of guided rotors are preferably used. Self excitation is provided by excitation coils mounted on the pole of the stator. The remanent magnetic field is sufficient to avoid the need of preexcitation. The excitation field magnetises the pole claws of the rotor in an alternating arrangement. The resulted rotating magnetic field induces three-phase AC voltage in the stator

windings. The magnetic flux leads from the core of the rotating rotor through a stator pole and a pole claw to the stator core. The line of magnetic force closes through the next claw of opposite polarity in the rotor core. In contrast to the slip-ring type electric generators in this case, the lines of magnetic force are passing through two additional airgaps. These types of generators without slip-rings are used mainly in heavy construction machines and special vehicles.

It is an object of the present invention to provide a rotor for electric generators with excellent power transforming efficiency. A further object of the invention is the potential for easy manufacturing at low costs.

The principal idea for a solution to the above problem is an advantageous laminated arrangement of magnets on the rotor or at the claws of the rotor which results in increased efficiency already at low speeds.

The rotor for an electric generator according to one aspect of the invention has an axle provided with an even number of ferrite-magnet segments, and surrounded by a grooved laminated stator with coils. The ferrite-magnet segments are arranged in at least two layers on the axle, and steel-magnet segments of one or more layers are provided between the ferrite-magnet segments. All of the segments attached to the axle together constitute a cylinder. The layers of the segments have identical polarity in radial direction from the axle, and the segments in any common layer have alternating polarity in circular direction.

In a preferred embodiment more than one ring, constituted by ferrite-magnet segments and steel-magnet segments, are attached to the axle, with an aluminium disc between them.

According to an other aspect of the invention, the generator has claw-type pole cups with permanent magnet discs being on the axle of the rotor within the pole cups, and surrounded by a grooved laminated stator with coils. The ferrite-magnet segments are attached to the claws of the claw-type pole cups in such an arrangement in which the segments constitute a cylinder around the axle.

According to a third aspect of the invention, the generator of the above claw-type pole has a further ferrite-magnet disc which is attached to the outer surface of the claw-type pole cups being perpendicular to the axle, and two claw-type pole cups are clamped between disc-like elements and are insulated by adhesive from them.

In a preferred embodiment of the above generator rotor more than one ring, constituted by ferrite-magnet segments and steel-magnet segments, are attached to the axle, with an aluminium disc between them.

It can be advantageous if the rotor is surrounded by two aluminium cups.

Further aspects of the generator according to the invention will be apparent from the description based on the following drawings.

Figure 1 shows a cross-section of a first rotor according to the invention.

Figure 2 shows another cross-section of the doubled embodiment of Figure 1.

Figure 3 shows a cross-section of a second rotor according to the invention before mounting together.

Figure 4 shows an axle elevation of the embodiment of Figure 1 with partial cross-section of a cup.

Figure 5 shows the mounted embodiment of Figure 3 in partial cross-section.

Figure 6 shows a developed embodiment of Figure 3 without the magnet segments. before mounting together in cross-section.

Figure 7 shows the mounted embodiment of Figure 6 with the magnet segments. in partial cross-section.

A possible embodiment of the generator rotor 10, as illustrated in Fig. 1, provided with an even number of ferrite-magnet segments 3 on the axle 1, and surrounded by a grooved laminated stator with coils. The ferrite-magnet segments 3 are arranged in two layers on the axle 1, and further similar steel-magnet segments 2 of two layers are provided between the ferrite-magnet segments 3 in such a way, that the segments 2 and 3 attached to the axle 1 together constitute a cylinder. This arrangement results in the greater efficiency of the magnetic force of steel-magnet segments 2. by preventing demagnetisation of said steel- magnet segments 2 due to applied ferrite-magnet segments 3. The steel-magnet segments 2 and the ferrite-magnet segments 3 have been attached to each other and to the axle 1 by adhesive. The layers of the steel-magnet segments 2 and ferrite- magnet segments 3 constitute symmetric sectors in Fig. 1 for example. Any consecutive segments 2,3 in a sector have an identical polarity in radial direction, taken from the axle 1. and any neighbouring segments 2,3 in a certain layer have alternating polarity in circular direction. In this respect we consider a certain direction from the magnetic pole N to the magnetic pole S as

polarity. A possible arrangement of the poles S and N is illustrated in Fig. 1 for the outer layer of ferrite-magnet segments 3 and for two sector including both segments 2 and 3 where according to the invention steel-magnet segments 2 are always at intermediate positions radially. The length of the segments 2 and 3 increases outwardly from the axle 1, but the gap between the segments 2 and 3 are of uniform thickness and the insulation of the adhesive filling the gaps is also uniform in each direction. The efficiency of the generator becomes greater if the rotor 10 is surrounded by two aluminium cups 8 which essentially encapsulate the rotor 10, and are fastened to that also by adhesive. The function of the cups 8 is to diminish the armature reaction. If higher energy demand occurs, the rotor 10 can be doubled, as it can be seen in Fig. 2. In this case the rotor 10 has an unchanged structure but two magnet arrangements are built on a common axle 1. An aluminium disc 9 is applied between the two magnet arrangements also in order to diminish the armature reaction. The aluminium cups 8 and the aluminium disc 9 have been insulated from each other and also from the axle 1, and have been attached to the rotor 10 by adhesive.

In an other embodiment of Fig. 3, 4 and 7 the rotor 10 is constructed of claw-type pole cups 4 with permanent magnet discs 5 being glued by adhesive onto the axle 1 of the rotor within the pole cups 4. Fig. 5 shows the two separate half elements of Fig. 3, including the pole cups 4 with claws 7, after being mounted together by screwing. Figure 4 shows an axle elevation of this embodiment of Fig. 3. A plurality of ferrite-magnet segments 3 are attached to the claws 7 of the claw-type pole cups 4 in such an arrangement in which the segments 3 constitute a cylinder around the axle 1. For the sake

of obtaining greater output power the ferrite-magnet segments 3 have been attached to the claws 7 of the claw-type pole cups 4 in two layers, between which two more layers of steel-magnet segments 2 are placed in such an arrangement in which these segments 2 constitute a cylinder around the axle 1. The segments 2 and 3 have identical polarity in radial direction, and in any common layer segments 2 and 3 have alternating polarity in circular direction.

In an alternative embodiment of the invention, as seen in Fig. 6 and 7, the rotor 10 is also constructed of claw-type pole cups 4 with permanent ferrite-magnet discs 5 being glued by adhesive onto the axle 1 of the rotor within the pole cups 4. A further ferrite-magnet disc 14 is attached to the outer surface of the claw-type pole cups 4 being perpendicular to the axle. Two claw-type pole cups 4 are clamped between two steel disc-like elements 6. and are insulated by adhesive from those. The disc-like elements 6 are connected to each other by threaded junction. Fig. 7 shows the two separate half elements of Fig. 6 after being mounted together by screwing. Besides the mechanical connection it serves to close the magnetic field, thus enhancing quadratically the useful magnetic field energy. Between the claw-type pole cup 4 and the ferrite-magnet disc 5 a first insulator ring 12 has been inserted, while between the further ferrite-magnet disc 14, the claw-type pole cup 4, the ferrite-magnet disc 5 and the steel disc-like element 6 a second insulator ring 13 has been inserted to ensure sufficient insulation of the magnets. This rotor 10 is again fitted to a known grooved and laminated stator.

The produceable power can also be enhanced again by applying ferrite-magnet segments 3 onto the claws 7 of the pole cup 4, and enhanced even more if the ferrite-magnet segments 3 are of at least two layers with one or more layers of steel- magnet segments 2 between them. The steel-magnet segments 2 and ferrite-magnet segments 3 have the same polarity arrangement as in the cases described before.

The aluminium cups 8 has the same role again in this embodiment.

Used adhesive 11 has to provide sufficient binding and good insulation in every embodiments, for which purpose, for example, a metal-glue or synthetic resin based adhesive can be appropriate.

Operation of the generators according to the invention with rotor 10 is very similar to that of the known generators. In most cases the rotor 10 insertable into a conventional stator without any modification, as it can be seen from Fig. 9, where the illustrated rotor 10 comprising only segments 2 and 3, but this can be substituted by a rotor 10 having claw-type pole cups 4 either provided with permanent ferrite-magnet discs 5 only or with additional further ferrite-magnet discs 14 as well. With up to 12 pairs of poles, a rotor built from segments is more advantageous; with more than this number, rotor having claw-type pole cups can be more suitable mainly from the points of easy manufacturing and overall sizes.

The generator construction according to the present invention shows advantage in eliminating the need of coal brushes and slip-rings. It can be immediately placed into a conventional stator without any modification. The amount of the produced energy is significantly enhanced. In accordance with the outer diameter of the rotor, ferrite-magnet and steel- magnet segments

can be adapted in any number for obtaining greater output electric current of the generator (due to the feed-back of the magnetic field). It is a further advantage that the operation takes place in a long wavelength (thermal wavelength) range, therefore these generators need no cooling. Its manufacturing is easy and low-cost, while the generator is relatively light in weight. The possible fields of use comprise vehicles, utilisation of wind-energy, and underwater applications. Its sparkless operation offers facilities where there is danger of explosion, or where radiofrequency interference must be avoided.

CLAIMS

1. A rotor for an electric generator, having an axle provided with an even number of ferrite-magnet segments, and surrounded by a grooved laminated stator with coils, characterised in that the ferrite-magnet segments (3) are arranged in at least two layers on the axle (1), and steel-magnet segments (2) of one or more layers are provided between the ferrite-magnet segments (3), and the segments (2,3) attached to the axle (1) all together constitute a cylinder, and the layers of the segments (2,3) have identical polarity in radial direction from the axle (1), and the segments (2,3) in any common layer have alternating polarity in circular direction.

2. A rotor for an electric generator, having claw-type pole cups with permanent magnet discs being on the axle of the rotor within the pole cups, and surrounded by a grooved laminated stator with coils, characterised in that ferrite- magnet segments (3) are attached to the claws (7) of the claw- type pole cups (4) in such an arrangement in which the segments (3) constitute a cylinder around the axle (1).

3. A rotor for an electric generator, having claw-type pole cups with permanent magnet discs being on the axle of the rotor within the pole cups, and surrounded by a grooved laminated stator with coils, characterised in that a further ferrite-magnet disc (14) is attached to the outer surface of the claw-type pole cups (4) being perpendicular to the axle (1), and two

claw-type pole cups (4) are clamped between disc- like elements and are insulated by adhesive from those.

4. A rotor according to claim 2, characterised in that the ferrite-magnet segments (3) attached to the claws of the claw-type pole cups (4) are of at least two layers, between of which one or more layers of steel-magnet segments (2) are placed in such an arrangement in which these segments (2) constitute a cylinder around the axle (1), and the segments (2,3) have identical polarity in radial direction from the axle (1), and the segments (2,3) in any common layer have alternating polarity in circular direction.

5. A rotor according to claim 1, characterised in that more than one ring, constituted by ferrite-magnet segments (3) and steel-magnet segments (2), are attached to the axle (1), with an aluminium disc (9) between them.

6. A rotor according to any of claims 1-5, characterised in that the rotor (10) is surrounded by two aluminium cups (8).

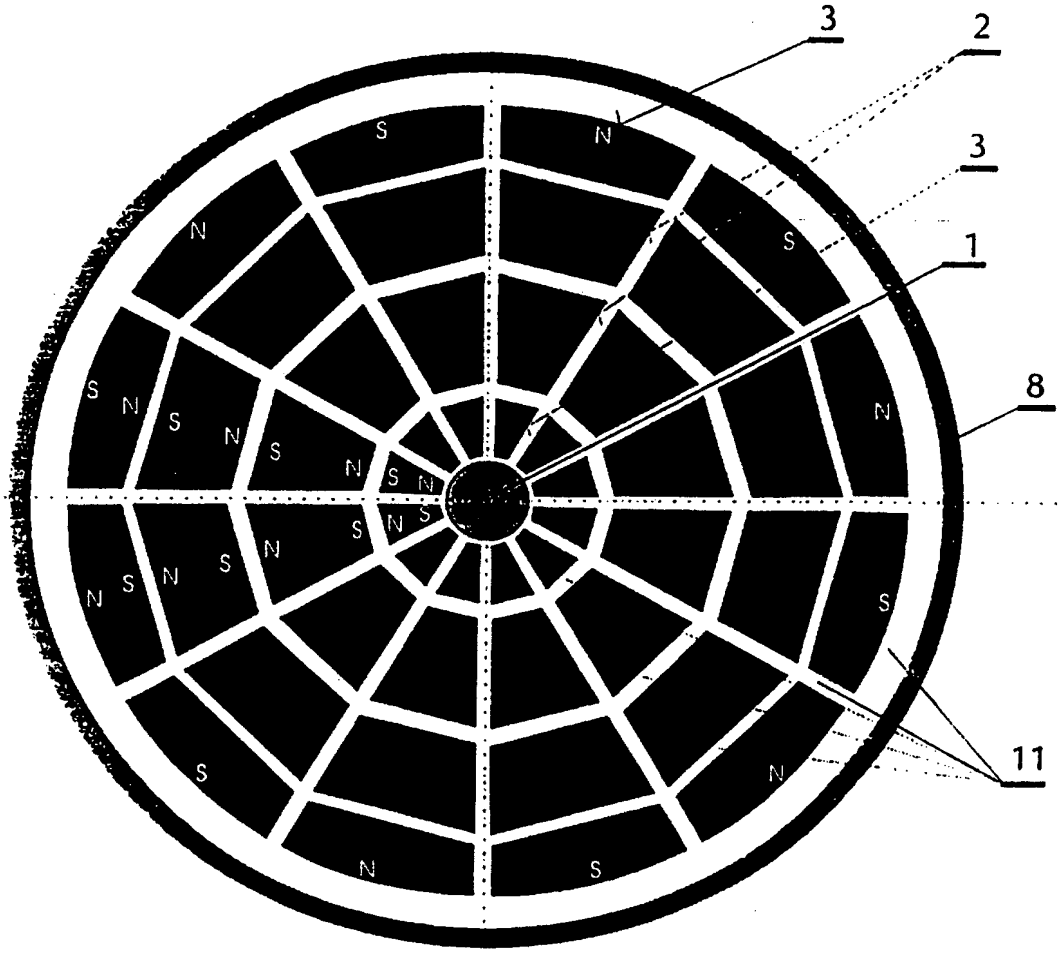

Fig 1

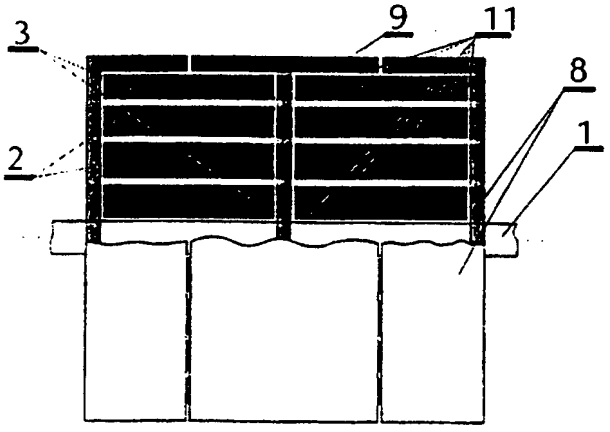

Fig 2

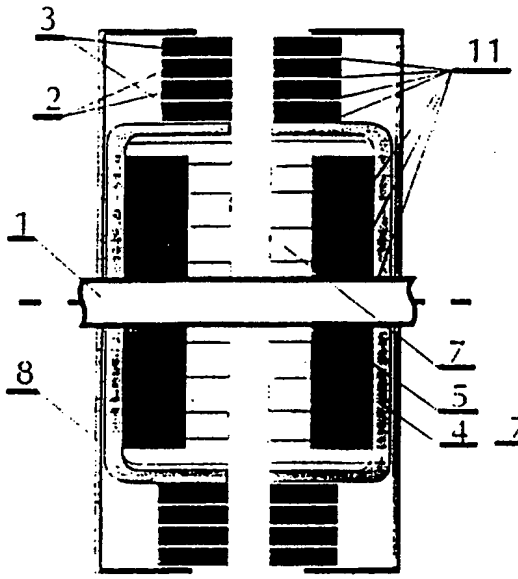

Fig 3

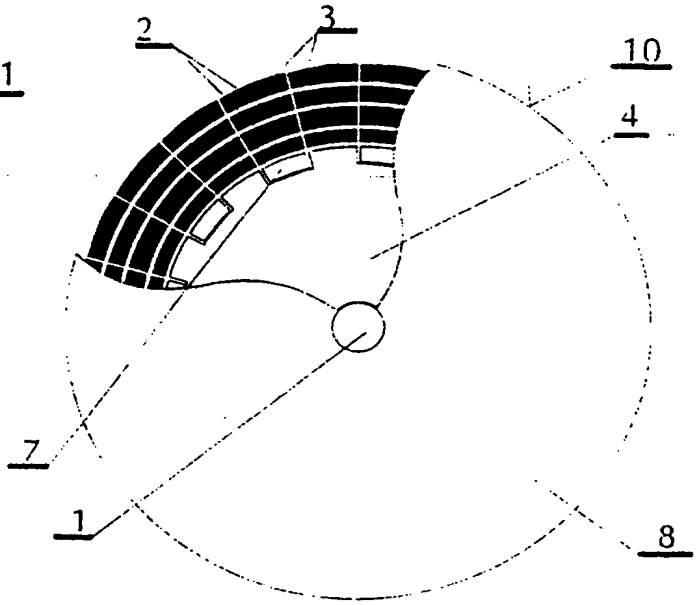

Fig 4

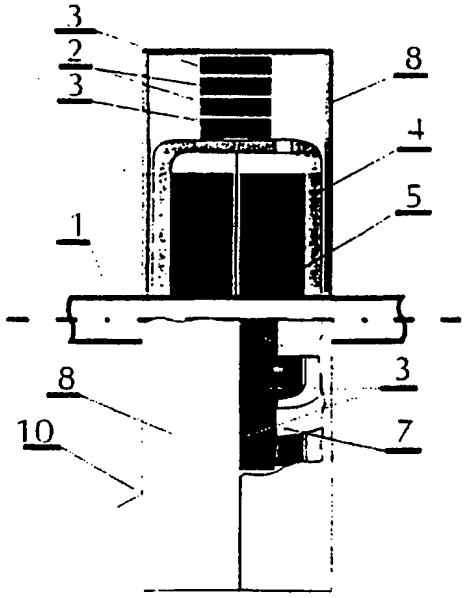

Fig 5

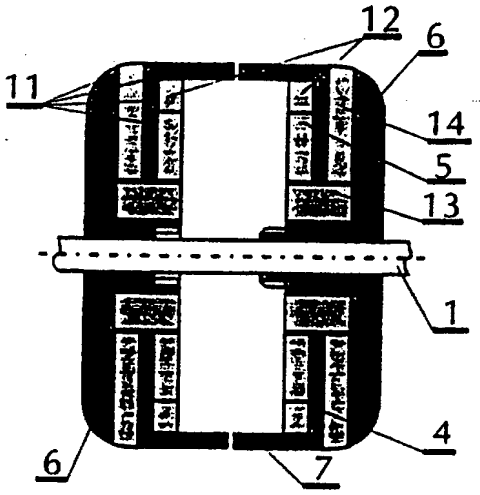

Fig 6

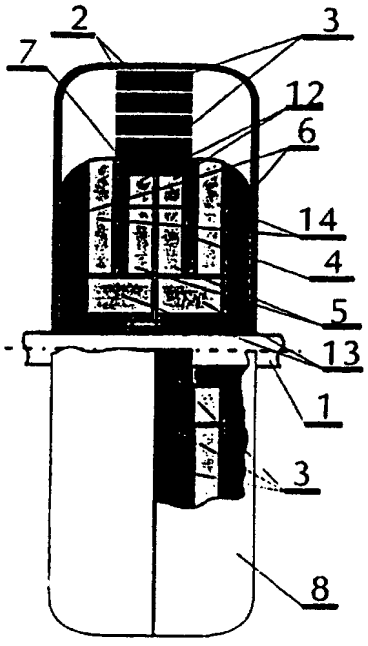

Fig 7

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(81) Designated States: AU, BR, BY, CA, CN, CZ, EE, JP, KR, LT, LV, PL, RO, RU, TR, UA, US, YU, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

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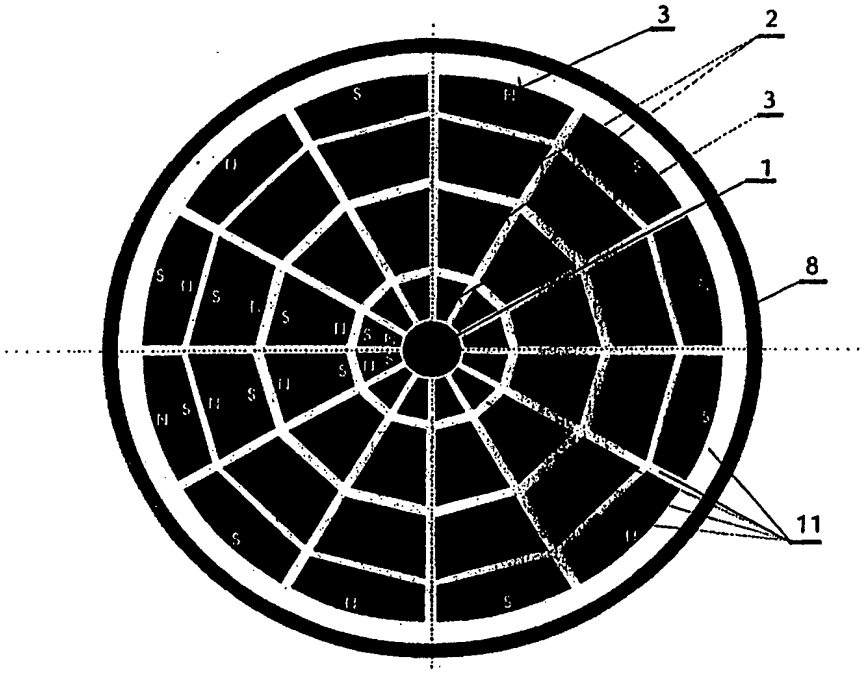
(57) Abstract

A rotor for an electric generator, having an axle (1) provided with an even number of ferrite–magnet segments (3), and surrounded by a grooved laminated stator with coils. The ferrite–magnet segments (3) are arranged in at least two layers on the axle (1), and steel–magnet segments (2) of one or more layers are provided between the ferrite–magnet segments (3), and the segments (2, 3) attached to the axle (1) all together constitute a cylinder, and the segments (2, 3) have identical polarity in radial direction from the axle (1), and the segments (2, 3) in any common layer have alternating polarity in circular direction.



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INTERNATIONAL SEARCH REPORT

Inte ional Application No
PCT/HU 97/00057

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H02K1/27

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H02K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	PATENT ABSTRACTS OF JAPAN vol. 010, no. 069 (E-389), 18 March 1986 & JP 60 219947 A (YASUKAWA DENKI SEISAKUSHO KK), 2 November 1985, see abstract ---	1
A	PATENT ABSTRACTS OF JAPAN vol. 012, no. 106 (E-596), 6 April 1988 & JP 62 235704 A (CANON INC), 15 October 1987, see abstract ---	1
A	GB 213 979 A (M-L MAGNETO SYNDICATE LIMITED) 19 April 1924 see the whole document ---	1

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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INTERNATIONAL SEARCH REPORT

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PCT/HU 97/00057

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 3 492 520 A (YATES WILLIAM W) 27 January 1970 see claim 1; figure 2	1
A	US 5 177 391 A (KUSASE SHIN) 5 January 1993 see column 6, line 19 - line 52; figures 6,7	2
A	FR 1 388 922 A (BEREX ESTABLISHMENT) 3 June 1965 see figure 2	2

2

national application No.

PCT/HU 97/00057

INTERNATIONAL SEARCH REPORT

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. CLAIMS : 1,2,4-6
2. CLAIMS : 3

FOR FURTHER INFORMATION PLEASE SEE FORM PCT/ISA/206 MAILED 22.04.98

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☒ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

1. Claims: 1,2,4-6

permanent magnet layered arrangement consisting of ferrite magnets and steel magnets

2. Claim : 3

claw-pole type permanent magnet rotor with additional magnet disc attached to the outer face of the poles

INTERNATIONAL SEARCH REPORT

information on patent family members

Inte onal Application No
PCT/HU 97/00057

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 213979 A		NONE	
US 3492520 A	27-01-70	BE 710723 A	17-06-68
		FR 1554325 A	17-01-69
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